CERTIFICATE

I, Hisako ITO, residing at 4-35-13, Takadanobaba, Shinjuku-ku, Tokyo, 169-0075 Japan, hereby certify that I am the translator of the attached document, namely a Certified Copy of Japanese Patent Application No. 10-068304 and certify that the following is a true translation to the best of my knowledge and belief.

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[Inventor]

[Address] c/o Seiko Epson Corporation, 3-5, Owa 3-chome, Suwa-shi, Nagano-ken

[Name] Shoji HINATA

[Applicant for Patent]

[Id. No.] 000002369

[Name] Seiko Epson Corporation

[Agent]

[Id. No.] 100093388

[Patent Attorney]

[Name] Kisaburo SUZUKI

[Phone No.] 0266-52-3139

[Sub-agent]

[Id. No.] 100095728

[Patent Attorney]

[Name] Masataka KAMIYANAGI

[Sub-agent]

[Id. No.] 100107261

[Patent Attorney]

[Name] Osamu SUZAWA

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[Title of the Invention] LIQUID CRYSTAL DISPLAY AND ELECTRONIC APPARATUS

[Claims]

[Claim 1] A liquid crystal display comprising a pair of substrates opposed to each other and combined together with a sealing material provided therebetween, a liquid crystal sealed in an area surrounded by the sealing material to form a display area, a plurality of first electrodes provided on one of the pair of substrates and each having a laminated structure including a transparent conductive film and a silver alloy film, and a color filter and a plurality of second electrodes provided on the other substrate, the color filter comprising an arrangement of a plurality of colorant layers having different colors,

wherein light transmitting regions for transmitting light from the one of the substrates through the transparent conductive electrode films are provided in a region in which the colorant layers of the color filter, the second electrodes, and the first electrodes overlap, and all the upper surface and the sides of the silver alloy film constituting each of the first electrodes are covered with the transparent conductive film.

[Claim 2] The liquid crystal display according to claim 1,

wherein the pattern of the silver alloy films constituting the respective first electrodes has window-shaped apertures functioning as the light transmitting regions.

[Claim 3] The liquid crystal display according to claim 1 or 2, wherein the width of the pattern of the transparent conductive films constituting the first electrodes is larger than that of the pattern of the silver alloy films so that the edges of the transparent conductive films function as the light transmitting regions.

[Claim 4] The liquid crystal display according to any one of claims 1 to 3, wherein the silver alloy films are provided only in a display area on the one of the substrates, and all the upper surfaces and the sides of the silver alloy films are covered with the transparent conductive films.

[Claim 5] The liquid crystal display according to any one of claims 1 to 4, wherein all surfaces including the upper and lower surfaces and the sides of the silver alloy films constituting the first electrodes are covered with the transparent conductive films.

[Claim 6] The liquid crystal display according to any one of claims 1 to 5, wherein the plurality of first electrodes are stripe-shaped segment electrodes, and the plurality of second electrodes are stripe-shaped common electrodes crossing the first electrodes.

[Claim 7] An electronic apparatus comprising the liquid

crystal display according to any one of claims 1 to 6.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a liquid crystal display and an electronic apparatus, and particularly relates to the construction of a transflective color liquid crystal display.

[0002]

[Description of the Related Art]

A reflective liquid crystal display does not use a light source such as a back light or the like, and thus consumes little electric power, and is conventionally widely used for accessory display sections of various portable electronic apparatuses and devices. However, the reflective liquid crystal display performs a display by utilizing external light such as natural light, illumination light, or the like, and thus has the problem of low visibility of a display in a dark place. Therefore, a liquid crystal display has been proposed, in which it utilizes external light in a bright place like a general reflective liquid crystal display, while it utilizes an internal light source for making a display visible in a dark place. Namely, the liquid crystal display uses a display system including a reflective mode system and a transmissive mode system, and

the display system is switched between the reflective mode display and transmissive mode display systems according to surrounding brightness, thereby permitting a clear display even in a dark environment while decreasing power consumption. In the specification of this application, this type of liquid crystal display is referred to as a "transflective liquid crystal display".

[0003]

As the transflective liquid crystal display, a liquid crystal display comprising a transflective film, i.e., a so-called half mirror, is generally known. In this transflective film, the thickness of a metal film of aluminum or the like, which is generally used as a reflecting film, is optimized so as to transmit light to some extent, and at the same time, reflect light to some extent. However, a deposition technique such as mask sputtering or the like is required for forming the transflective film, thereby complicating the process and causing the fault that a large variation in thickness increases variations in transmittance and reflectance.

[0004]

Therefore, in order to overcome the fault of the transflective film, a liquid crystal display comprising a light transmitting slit formed in a reflecting film has been proposed. Fig. 10 shows an example of a passive matrix

transflective color liquid crystal display. In the liquid crystal display 100 shown in Fig. 10, a liquid crystal 103 is held between a pair of transparent substrates 101 and 102. Also, a reflecting film 104, a color filter 105 comprising colorant layers 105r, 105g and 105b having different colors of red (R), green (G) and blue (B), an overcoat film 106, and a silicon oxide film 107 are laminated in turn on the lower substrate 101, and stripe-shaped segment electrodes 108 each comprising a transparent conductive film of indium tin oxide (abbreviated to "ITO" hereinafter) are formed on the silicon oxide film 107. On the other hand, common electrodes 109 each comprising a transparent conductive film of ITO are formed in stripes on the upper substrate 102 perpendicularly to the segment electrodes 108. The reflecting film 104 comprises a metal film of aluminum or the like, which has high reflectance. The reflecting film 104 also has a light transmitting slit 110 formed for every pixel. Furthermore, polarizer plates (not shown in the drawing) are provided on the outer surfaces of the upper and lower substrates, respectively, and a back light (not shown in the drawing) is disposed on the lower side of the lower substrate 101.

[0005]

When the liquid crystal display 100 having the above construction is used in a reflective mode in a bright place,

external light incident on the upper surface of the upper substrate 102 is transmitted through the liquid crystal 103, reflected by the surface of the reflecting film 104, again transmitted through the liquid crystal 103 and then emitted from the upper substrate 102. When the liquid crystal display 100 is used in a transmissive mode in a dark place, light emitted from the back light provided below the lower substrate 101 is transmitted through the slits 110 of the reflecting film 104, transmitted through the liquid crystal 103 and then emitted from the upper substrate 102. The light contributes to a display in each of the display modes.

[0006]

[Problems to be Solved by the Invention]

In a transflective liquid crystal display, a metal film of aluminum or the like is conventionally used as a reflecting film. However, a brighter screen has been recently demanded, and thus a silver-palladium-copper alloy (Ag-Pd-Cu, abbreviated to "APC" hereinafter) having higher reflectance than aluminum has been used. However, APC has the property that it has low water resistance in the production process, and thus APC in a pattern is eluted by electrical ionization, thereby causing electromigration and electrolytic corrosion (corrosion) due to the electromigration. There is thus the problem of reliability. Therefore, it is difficult to use APC singly, and ITO is

laminated above or below APC to form a laminated film.

[0007]

Fig. 9 shows an example of a transflective color liquid crystal display comprising light transmitting slits formed in reflecting electrodes each comprising a laminated film of APC and ITO. In the liquid crystal display 90 shown in Fig. 9, a liquid crystal 93 is held between a pair of transparent substrates 91 and 92. Segment electrodes 97 each having a laminated structure comprising an APC film 95 having slits 94, and an ITO film 96 formed thereon are formed in stripes on the lower substrate 91. Furthermore, an alignment film 98 is formed on the segment electrode 97. On the other hand, a color filter 89 comprising colorant layers 89r, 89g and 89b having R, G and B colors, an overcoat film 88, common electrodes 87 each comprising an ITO film, and an alignment film 86 are formed in turn on the upper substrate 92. Furthermore, polarizer plates (not shown in the drawing) are provided on the outer surfaces of the lower and upper substrates, respectively, and a back light (not shown in the drawing) is disposed on the lower side of the lower substrate 91. In the above-described construction, the laminated film comprising the APC film 95 and the ITO film 96 formed on the lower substrate 91 functions as a transflective film, and at the same time, functions as an electrode for driving the liquid crystal. Therefore, the

color filter cannot be formed on the lower substrate 91, and the color filter 89 is formed on the upper substrate 92.

[0008]

Also, APC has the property that it has not only high reflectance but also lower resistivity than that of ITO or the like, and is thus suitable as an electrode and wiring material. Particularly, in comparison with ITO, APC has a resistivity of $3.9 \times 10^{-6}\ \Omega\cdot m$, which is about 1/50 of the resistivity of $2 \times 10^{-4}\ \Omega\cdot m$ of ITO. Namely, with the same thickness, the width of APC wiring required for obtaining a resistance value is about 1/50 of the width of ITO wiring required for obtaining the same resistance value. Therefore, in the liquid crystal display shown in Fig. 9 in which APC is used for lead wiring between an electrode and a driving semiconductor element, lead wiring can be made fine, as compared with the liquid crystal display shown in Fig. 10 in which ITO is used for lead wiring. Therefore, a non-display area (referred to as a "frame area" hereinafter) around an effective display area can be decreased (narrowing of the frame). Particularly, a liquid crystal display having a narrow frame can be contained in a restricted space in a casing, and the quantity of information which can be displayed can be increased relative to the occupied area of the liquid crystal display. Therefore, the liquid crystal display is suitable for a portable small electronic

apparatus such as a cellular phone or the like.

[0009]

However, in the conventional liquid crystal display shown in Fig. 9, the APC constituting the segment electrodes and lead wiring causes electromigration in repeated use, thereby possibly causing the defect that the electrodes and wiring are narrowed or broken according to circumstances. There is thus the problem of low reliability.

[0010]

The present invention has been achieved for solving the above problem, and an object of the present invention is to provide a transflective color liquid crystal display capable of preventing electromigration due to APC and having high reliability and the advantages of APC that a frame area can be narrowed due to the low resistance of lead wiring, and a bright display can be performed in a reflective mode.

[0011]

[Means for Solving the Problems]

In order to achieve the object, a liquid crystal display of the present invention comprises a pair of substrates opposed to each other and combined together with a sealing material provided therebetween, a liquid crystal sealed in an area surrounded by the sealing material to form a display area, a plurality of first electrodes provided on one of the substrates and each having a laminated structure

including a transparent conductive film and a silver alloy film, and a color filter and a plurality of second electrodes provided on the other substrate, the color filter comprising a plurality of colorant layers having different colors, wherein light transmitting regions for transmitting light from the one of the substrates through the transparent conductive electrode films are provided in a region in which the colorant layers of the color filter, the second electrodes, and the first electrodes overlap, and all the upper surface and the side of the silver alloy film constituting each of the first electrodes are covered with the transparent conductive film.

In the present invention, the "display area" means the area surrounded by the sealing material, the liquid crystal being sealed therein.

[0012]

The liquid crystal display of the present invention has the advantage that since each of the first electrodes has the laminated structure comprising the silver alloy film and the transparent conductive film, a bright display can be performed in a reflective mode.

Furthermore, in the liquid crystal display of the present invention, all the upper surfaces and the sides of the silver alloy films constituting the respective first electrodes are covered with the transparent conductive films,

thereby preventing electromigration in the silver alloy films constituting the first electrodes and preventing the occurrence of a defect due to the electromigration. Therefore, the liquid crystal display has high reliability.

[0013]

Examples of the form of the light transmitting regions include a window-like aperture formed in the silver alloy film pattern, and a light transmitting region formed at the edge of each transparent conductive film in such a manner that the silver alloy film is absent from the edge, and the width of the transparent conductive film pattern is larger than that of the silver alloy film pattern. Alternatively, these two forms may be combined.

[0014]

In the liquid crystal display, preferably, the silver alloy films are provided only in the display area on the one of the substrates, and all the upper surfaces and the sides of the silver alloy films are covered with the transparent conductive films.

The silver alloy films provided in the display area constitute the respective first electrodes, and function as reflecting films. Since the silver alloy films have high reflectance to permit a bright display in a reflective mode. However, there is the problem that the high reflectance of the silver alloy films which can provide a bright display is

decreased by a heat treatment in the process for manufacturing the liquid crystal display.

In the liquid crystal display, all the upper surfaces and the sides of the silver alloy films provided in the display area are covered with the transparent conductive films, and thus the silver alloy films functioning as the reflecting films are protected by the transparent conductive films without being exposed after the transparent conductive films are formed in the process for manufacturing the liquid crystal display. Therefore, a decrease in reflectance of the silver alloy films can be effectively prevented, and the liquid crystal display can provide a bright display in the reflective mode. Also, moisture adhesion to the silver alloy films provided in the display area can be effectively prevented in the process for manufacturing the liquid crystal display, and the occurrence of a defect due to electromigration in the display area can be prevented to improve reliability.

[0015]

In the liquid crystal display, all surfaces including the upper and lower surfaces and the sides of the silver alloy films constituting the respective first electrodes are preferably covered with the transparent conductive films.

In the liquid crystal display, the problem of corrosion due to moisture adhesion in the manufacturing process and

the problem of electromigration due to contamination of the silver alloy film surfaces can be more securely avoided. Therefore, the liquid crystal display has higher reliability.

[0016]

An example of a liquid crystal display to which the present invention can be applied is a passive matrix liquid crystal display. In this case, the plurality of the first electrodes are stripe-shaped segment electrodes, and the plurality of the second electrodes are stripe-shaped common electrodes crossing the first electrodes. Also, the present invention can also be applied to an active matrix liquid crystal display using thin film diodes (abbreviated to "TFD" hereinafter) as switching elements.

[0017]

An electronic apparatus of the present invention comprises the liquid crystal display of the present invention. This construction can realize an electronic apparatus having high reliability and comprising an excellent display section capable of producing a bright display in a reflective mode.

[0018]

[Description of the Embodiments]

[First embodiment]

A first embodiment of the present invention will be described below with reference to Figs. 1 to 3.

Fig. 1 is a plan view showing the whole configuration of a liquid crystal display according to this embodiment. Fig. 2 is an enlarged view of a display area of the liquid crystal display, and Fig. 3 is a sectional view taken along line A-A in Figs. 1 and 2. In this embodiment, the present invention is applied to a passive matrix transflective color liquid crystal display. In all the figures, in order to make the figures easy to see, the thickness and dimensional ratios of each of components are different from actual values.

[0019]

As shown in Fig. 1, the liquid crystal display 1 of this embodiment comprises a lower substrate 2 (one of substrates) having a rectangular planar shape, and an upper substrate 3 (the other substrate) having the same rectangular shape are opposed to each other with a sealing material 4 provided therebetween. A portion of the sealing material 4 is open on one side (the upper side shown in Fig. 1) of each of the substrates 2 and 3 to form a liquid crystal injection port 5. A liquid crystal is sealed in the space surrounded by both substrates 2 and 3 and the sealing material 4, and the liquid crystal injection port 5 is sealed with a sealant 6. In this embodiment, the outside dimensions of the lower substrate 2 are larger than those of the upper substrate 3. The upper substrate 3 and the lower

substrate 2 are combined together so that the edges thereof coincide with each other on one side (the upper side shown in Fig. 1), and the edge of the lower substrate 2 projects outward from the upper substrate 3 on the other three sides (i.e., the lower side, the right side, and the left side shown in Fig. 1). In addition, a driving semiconductor element 7 is mounted at the lower end of the lower substrate 2, for driving the electrodes of both the upper substrate 3 and the lower substrate 2. In Fig. 1, reference numeral 8 denotes a light shielding layer (peripheral parting line) for shielding the effective display area from ambient light.

[0020]

As shown in Figs. 1 and 2, in this embodiment, a plurality of segment electrodes 10 (first electrodes) is formed in stripes on the lower substrate 2 to extend in the longitudinal direction of the drawing. On the other hand, a plurality of common electrodes 11 (second electrodes) is formed in stripes on the upper substrate 3 to extend in the transverse direction of the drawing perpendicular to the segment electrodes 10. A color filter 13 comprises colorant layers 13r, 13g and 13b which are arranged corresponding to the extension directions of the respective segment electrodes 10, and three pixels of R, G and B arranged in the transverse direction of Fig. 2 form one dot on a screen. Although a sectional structure will be described in detail

below, each of the segment electrodes 10 has a laminated structure comprising an APC film and an ITO film. In this embodiment, the APC pattern has two light transmitting windows 12 (light transmitting regions) in each pixel so that the APC films function as transflective films. The windows 12 are arranged in a staggered form as the colorant layers 13r, 13g, and 13b of the color filter 13 are seen in the longitudinal direction over a plurality of pixels.

[0021]

As shown in Fig. 1, for the common electrodes 11 in the upper half of the plurality of common electrodes 11 shown in Fig. 1, lead wirings 14 are extended from the right ends to the sealing material 4. The lead wirings 14 are electrically connected between the upper substrate 3 and the lower substrate 2 through vertical conductive materials comprising anisotropic conductive particles mixed in the sealing material 4, led to the peripheral portion of the lower substrate 2, and further connected to output terminals of the driving semiconductor element 7. Similarly, for the common electrodes 11 in the lower half shown in Fig. 1, lead wirings 14 are extended from the left ends of the common electrodes 11 to the sealing material 4, as shown in Fig. 3. The lead wirings 14 are electrically connected to the lower substrate 2 through the vertical conductive materials comprising anisotropic conductor particles 41 mixed in the

sealing material 4, led to the peripheral portion of the lower substrate 2, and further connected to the output terminals of the driving semiconductor element 7. On the other hand, for the segment electrodes 10, lead wirings 15 are extended from the lower ends of the segment electrodes 10 to the sealing material 4, and connected to the output terminals of the driving semiconductor element 7, as shown in Fig. 1. In this embodiment, each of the lead wirings 14 and 15 comprises a laminated film composing an APC film and an ITO film. Also, input wirings 16 are provided to extend from the lower end of the lower substrate 2 to input terminals of the driving semiconductor element 7, for supplying various signals to the driving semiconductor element 7.

[0022]

In the sectional structure shown in Fig. 3, the segment electrodes 10 each having a two-layer structure comprising the APC film 18 and the ITO film 19 formed thereon are formed in stripes on the lower substrate 2 comprising a transparent substrate of glass or plastic in the direction passing through the drawing, and an alignment film 20 which comprises polyimide and which was subjected to, for example, surface rubbing, is formed on the segment electrodes 10.

In this embodiment, each of the segment electrodes 10 and the lead wirings 14 and 15 has a structure in which the

width of the ITO pattern is larger than that of the APC pattern so that not only the upper surfaces of the APC films 18 are covered with the ITO films 19, but also the sides (sections) of the APC films are covered with the ITO films 19.

[0023]

On the other hand, the color filter 13 comprising the colorant layers 13r, 13g and 13b of R, G and B colors is formed on the upper substrate 3 comprising a transparent substrate of glass or plastic, and an overcoat film 21 is formed on the color filter 13, for planarizing the steps between the respective colorant layers and protecting the surfaces of the colorant layers. The overcoat film 21 may comprise either an acrylic or polyimide resin film or an inorganic film such as a silicon oxide film. Furthermore, the common electrodes 11 each comprising an ITO single layer film are formed in stripes on the overcoat film 21 in parallel with the drawing, and an alignment film 22 comprising a polyimide film subjected to, for example, surface rubbing is formed on the common electrodes 11. The liquid crystal 23 comprising a STN (Super Twisted Nematic) liquid crystal is held between the upper substrate 3 and the lower substrate 2. Furthermore, a back light (not shown in the drawing) is disposed below the lower substrate 2.

[0024]

Furthermore, black stripes 25 (light shielding layers) are formed on the upper substrate 3. The black stripes 25 comprise, for example, resin black or a metal having relatively low reflectance, such as chromium, and are provided to partition the color filter 13 into the colorant layers 13r, 13g, and 13b of R, G, and B colors. In this embodiment, the width W of the black stripes is larger than the distance P1 (distance between the segment electrodes) between the adjacent pixels in the ITO pattern 19, and coincides with the distance P2 in the APC pattern 18. As shown in Fig. 2, the outer lines defining the segment electrodes 10 show the edges of the ITO pattern 19, and the inner lines show the edges of the APC pattern 18, but the lines defining the black stripes 25 overlap with the lines showing the edges of the APC pattern 18.

[0025]

In the liquid crystal display having the above-described basic structure, each of the segment electrodes 10 and the wirings 14 and 15 has a two-layer structure comprising the APC film 18 and the ITO film 19. The APC film 18 has the property that it has low water resistance, and easily causes electromigration during use. However, in this embodiment, in each of the segment electrodes 10 and the wirings 14 and 15, all the upper and side surfaces of the APC film 18 are completely coated with the ITO film 19

to avoid the problem of corrosion due to moisture adhesion during the manufacture process, and the problem of electromigration due to surface contamination of the APC films 18. Therefore, the liquid crystal display has high reliability. Furthermore, the reflectance of the APC films 18 which are provided in the display area and function as reflecting films can be prevented from decreasing during the manufacture process, thereby manufacturing, with high yield, an excellent liquid crystal display capable of producing a bright display in a reflective mode.

[0026]

In the liquid crystal display having the above-descried basic structure, the APC pattern constituting the segment electrodes functions as a transflective film. Therefore, in a conventional structure, light emitted from a back light always leaks from the regions between the adjacent segment electrodes to cause color mixing. However, in the liquid crystal display 1 of this embodiment, the back stripes 25 are provided to completely cover the spaces between the adjacent segment electrodes 10 in the APC pattern 18, thereby preventing light leakage and preventing color mixing. Consequently, it is possible to realize a liquid crystal display in which the brightness of a reflective mode display can be improved by using the APC films having excellent reflectance, and color chroma in a transmissive mode can be

improved to make each color clearly visible as compared with a conventional liquid crystal display.

In this embodiment, furthermore, the black stripes 25 are formed in the color filter 13 on the upper substrate 3, and thus a measure against color mixing can be easily provided without complicating the manufacturing process, particularly, the process for manufacturing the lower substrate 2 side.

[0027]

In the whole construction of the device, the resistance of the lead wirings 14 and 15 including the APC films is decreased to permit narrowing of the wirings, thereby realizing narrowing of the frame. In this embodiment, furthermore, the segment electrodes 10 and the common electrodes 11 are driven by the driving semiconductor element 7 provided on the lower substrate 2 using the vertical conductive materials, thereby permitting narrowing of the frame as a whole. The narrowing of the frame permits the production of a liquid crystal display suitable for a small portable electronic apparatus.

[0028]

[Second embodiment]

A second embodiment of the present invention will be described below with reference to Figs. 4 and 5.

The whole construction of a liquid crystal display of

this embodiment is the same as that of the first embodiment shown in Fig. 1, and thus detailed description is omitted. The second embodiment is different from the first embodiment in the planar shape of segment electrodes and the laminated structure of each of the segment electrodes and lead wirings. Therefore, only these portions will be described with reference to Figs. 4 and 5. Fig. 4 is an enlarged view of a display area of the liquid crystal display of this embodiment, and Fig. 5 is a sectional view taken along line B-B in Fig. 4. In Figs. 4 and 5, the components common to those shown in Figs. 2 and 3 are denoted by the same reference numerals.

[0029]

As shown in Fig. 4, in the display area, a plurality of segment electrodes 30 is formed in stripes on the lower substrate 2 to extend in the longitudinal direction of the drawing. On the other hand, a plurality of common electrodes 11 is formed in stripes on the upper substrate 3 to extend in the transverse direction of the drawing perpendicularly to the segment electrodes 30. The color filter 13 comprises colorant layers 13r, 13g and 13b which are arranged corresponding to the extension direction of the segment electrodes 30, and three pixels of R, G and B arranged in the transverse direction of Fig. 2 form one dot on a screen. This basic structure is the same as in the

first embodiment.

[0030]

In the first embodiment shown in Fig. 3, each of the segment electrodes 10 and the lead wirings 14 and 15 has a two-layer structure comprising the APC film 18 and the ITO film 19. However, in this embodiment shown in Fig. 5, each of the segment electrodes 30 and lead wirings 24 has a three-layer structure in which and ITO film 35, an APC film 31, an ITO film 32 are laminated in turn.

In this embodiment, in the structure of each of the segment electrodes 30 and the lead wirings 24, the ITO film 32 is provided to cover the upper surface and sides (section) of the APC film 31, and the ITO film 35 is provided below the APC film 31 so as to cover the bottom surface of the APC film 31.

[0031]

Unlike in the first embodiment, in this embodiment, light transmitting windows are not formed in the APC pattern of the segment electrodes 30. On the other hand, like in the first embodiment, black stripes 33 (light shielding layers) comprising resin black or a metal such as chromium are provided on the upper substrate 3 to partition the color filter into the respective colorant layers 13r, 13g, and 13b of R, G, B colors. This embodiment is different from the first embodiment in that the width W of the black stripes 33

coincides with the pitch P1 (pitch of the segment electrodes 30) between the adjacent pixels in the ITO pattern 32, and is smaller than the pitch P2 in the APC pattern 31. Furthermore, in the step of assembling the liquid crystal display having the above construction, assuming that a deviation (for example, maximum possible deviation) occurring in bonding the upper and lower substrates 3 and 2 together is E, the dimension D (corresponding to the dimension from the edge of the ITO pattern 32 to the edge of the APC pattern 31 in each segment electrode 30 in this embodiment) from the edge of each black stripe 33 to the edge of the APC pattern is set to be larger than the deviation E ($D \geq E$).

[0032]

As shown in Fig. 4, the outer lines defining the segment electrodes 30 show the edges of the ITO pattern 32, and the inner lines show the edges of the APC pattern 31. However, the lines defining the black stripes 33 overlap the lines showing the edges of the ITO pattern 32. Namely, in a plan view, the APC pattern 31 is absent from the right and left elongated portions of each segment electrode 30, and only the ITO pattern 32 is present in the portions. Therefore, these portions are not covered with the black stripes 33 and thus function as light transmitting regions through which light emitted from the back light is

transmitted in a transmissive mode. In the description below, the regions are referred to as "side slits 34" for convenience's sake.

[0033]

In this embodiment, the side slits 34 correspond to light transmitting regions formed at the edges of the segment electrodes 30 so that only the ITO pattern 32 is present at the edges, and the light transmitting windows provided in the first embodiment are not formed to decrease the width of the APC pattern 31. The side slits 34 not only simply function as the light transmitting regions but also function as mechanisms for preventing a decrease in luminance due to alignment shift in the reflective mode. Namely, like in the first embodiment shown in Fig. 3, when the width W of the black stripes 25 coincides with the space P2 of the APC pattern 18, and the edges of the black stripes 25 overlap the edges of the APC pattern 18, even a slight alignment shift causes the black stripes 25 to hang over the APC pattern 18 to decrease the effective area of the APC pattern 18 as a reflecting film, thereby causing the problem of darkening a reflective mode display. However, when an alignment shift does not occur, there is no problem.

[0034]

On the other hand, in this embodiment, the side slits 34 are provided so that the width of the side slits 34

(corresponding to the dimension from the edges of the black stripes 33 to the edges of the APC pattern 31) is larger than an alignment shift. Therefore, even if an alignment shift occurs, the black stripes 33 do not hang over the APC pattern 31. When an alignment shift occurs, the width of the side slit 34 on one of the sides of each pixel decreases, and accordingly the width of the side slit 34 on the opposite side increases, thereby exhibiting a constant quantity of light transmitted through the pixels as a whole. Therefore, it is possible to provide a structure with high resistance to an alignment shift in which even if an alignment shift occurs, a reflective mode display does not darken, and color mixing of the color filter can be prevented by the black stripes. This is a characteristic effect of this embodiment.

[0035]

In this embodiment, all the upper and lower surfaces and the sides of the APC films 31 constituting the segment electrodes 30 and the lead wirings 24 are completely covered with the ITO films 32 and 35, and all surfaces of the APC films 31 are covered with the ITO films 32 and 35. Therefore, the problem of corrosion due to moisture adhesion in the manufacturing process and the problem of electromigration due to surface contamination of the APC films 31 can be more securely avoided. Therefore, the

liquid crystal display has higher reliability.

[0036]

This embodiment also has the same effects as the first embodiment that the brightness of a reflective mode display can be improved by using the APC films, the color chroma in a transmissive mode can be improved, the process for manufacturing the lower substrate is not complicated, and the frame of the device can be narrowed.

[0037]

[Third embodiment]

A third embodiment of the present invention will be described below with reference to Fig. 11.

This embodiment is different from the first embodiment in that lead wiring has a single layer structure comprising only an ITO film. Since the other portions are the same as in the first embodiment shown in Figs. 1 to 3, detail description is omitted.

Fig. 11 is a sectional view illustrating a liquid crystal display of the third embodiment, taken along line A-A in Fig. 2. In Fig. 11, components common to Fig. 3 are denoted by the same reference numerals.

[0038]

In the first embodiment shown in Fig. 3, each of the segment electrodes 10 and the lead wirings 14 has a two-layer structure comprising the APC film 18 and the ITO film

19. However, in this embodiment, the lead wirings 14 has a single-layer structure comprising only an ITO film 19, as shown in Fig. 11.

In this embodiment, the APC films 18 are provided only in the display area on the lower substrate 2, and like in the first embodiment, all the upper surfaces and sides (sections) of the APC films 18 constituting the segment electrodes 10 are covered with the ITO films 19.

[0039]

The lead wirings 14 are disposed outside the sealing material 4 and are thus easily contaminated. However, in this embodiment, as shown in Fig. 11, each of the lead wirings 14 has a single-layer structure comprising only the ITO film 19 to avoid the problem of electromigration due to surface contamination of an APC film constituting lead wiring.

In this embodiment, each of the segment electrodes 10 has a two-layer structure comprising the APC film 18 and the ITO film 19, and all the upper surface and the sides of the APC film 18 are completely covered with the ITO film 19 constituting the segment electrode 10. Therefore, like in the first embodiment, the problem of corrosion due to moisture adhesion in the manufacturing process and the problem of electromigration due to surface contamination of the APC films 18 can be avoided. Therefore, the liquid

crystal display has high reliability.

[0040]

[Electronic apparatus]

Examples of an electronic apparatus using the liquid crystal display according to any one of the above-described embodiments will be described below.

Fig. 6 is a perspective view showing an example of a cellular phone. In Fig. 6, reference numeral 1000 denotes a cellular phone body, and reference numeral 1001 denotes a liquid crystal display section using the liquid crystal display.

[0041]

Fig. 7 is a perspective view showing an example of a wristwatch-type electronic apparatus. In Fig. 7, reference numeral 1100 denotes a watch body, and reference numeral 1101 denotes a liquid crystal display section using the liquid crystal display.

[0042]

Fig. 8 is a perspective view showing an example of a portable information processor such as a word processor or a personal computer. In Fig. 8, reference numeral 1200 denotes an information processing unit, reference numeral 1202 denotes an input section such as a keyboard, reference numeral 1204 denotes an information processor body, and reference numeral 1206 denotes a liquid crystal display

section using the liquid crystal display.

[0043]

Each of the electronic apparatuses shown in Figs. 6 to 8 comprises the liquid crystal display section using the liquid crystal display of any one of the above embodiments, and thus an electronic apparatus having light reliability and being capable of producing a bright display in a reflective mode can be realized.

[0044]

The technical field of the present invention is not limited to the above-described embodiments, and various modifications can be made within the scope of the gist of the present invention. Although, in the above-descried two embodiments, the black stripes are provided between the colorant layers of the color filter provided on the upper substrate, the black stripes may be provided between other layers. Alternatively, the black stripes may be provided on the lower substrate as long as no problem occurs even if the process for manufacturing the lower substrate is slightly complicated. In this case, there is no problem of alignment in bonding between the black stripes and the APC pattern.

[0045]

Even if the black stripes are provided in regions along the spaces between the adjacent common electrodes instead of being provided in regions along the spaces between the

adjacent segment electrodes, color mixing can be prevented to some extent. However, in view of the features that the direction along the spaces between the segment electrodes coincides with the direction of partition of the different colors of the color filter, and that the width of the segment electrodes is generally about 1/3 of the width of the common electrodes, and thus, in the construction of the second embodiment, the effect of a decrease in reflectance due to an alignment shift becomes remarked when the black stripes are provided along the segment electrodes, it is effective to provide the black stripes in the regions along the spaces between the adjacent segment electrodes like in the above-descried embodiments.

[0046]

Although the light transmitting windows and the side slits are provided in the first embodiment and the second embodiment, respectively, both the windows and the side slits may be provided. The shapes, dimensions, numbers, and formation positions of the windows and the side slits may be appropriately determined according to the luminance balance between the reflective mode and the transmissive mode, and the display appearance. Furthermore, besides the APC film, a silver alloy film such as a silver-palladium alloy (AP) film may be used as a silver alloy film.

Although, in the above-described embodiments, the

present invention is applied to a passive matrix liquid crystal display, the present invention can also be applied to an active matrix liquid crystal display comprising TFDs as switching elements.

[0047]

[Advantages]

As described above, the present invention can avoid the problem of corrosion due to moisture adhesion to a silver alloy film in the manufacturing process, and the problem of electromigration due to surface contamination of a silver alloy film, and can thus realize a liquid crystal display having high reliability. Since a silver alloy film having excellent reflectance is used as a transflective film, a liquid crystal display capable of producing a bright display in a reflective mode can be realized. Furthermore, since a silver alloy film having low resistivity is used for electrodes and wiring, a wiring width can be decreased to achieve frame narrowing, and a liquid crystal display suitable for a small portable electronic apparatus can e provided.

[Brief Description of the Drawings]

[Fig. 1] Fig. 1 is a plan view showing the whole construction of a liquid crystal display common to first and second embodiments of the present invention.

[Fig. 2] Fig. 2 is an enlarged plan view showing a

display area of the liquid crystal display of the first embodiment.

[Fig. 3] Fig. 3 is a sectional view taken along line A-A in Figs. 1 and 2.

[Fig. 4] Fig. 4 is an enlarged plan view showing a display area of the liquid crystal display of the second embodiment.

[Fig. 5] Fig. 5 is a sectional view taken along line B-B in Fig. 4.

[Fig. 6] Fig. 6 is a perspective view showing an example of an electronic apparatus according to the present invention.

[Fig. 7] Fig. 7 is a perspective view showing another example of an electronic apparatus according to the present invention.

[Fig. 8] Fig. 8 is a perspective view showing a further example of an electronic apparatus according to the present invention.

[Fig. 9] Fig. 9 is a sectional view showing an example of a liquid crystal display using a laminated film of APC and ITO as a transflective film.

[Fig. 10] Fig. 10 is a sectional view showing an example of a liquid crystal display using an Al film as a transflective film.

[Fig. 11] Fig. 11 is a sectional view illustrating a

liquid crystal display according to a third embodiment, taken along line A-A in Fig. 2.

[Reference Numerals]

1 liquid crystal display

2 lower substrate (one of substrates)

3 upper substrate (the other substrate)

10, 30 segment electrode (first electrode)

11 common electrode (second electrode)

12 window (light transmitting region)

13 color filter

13r, 13g, 13b colorant layer

18, 31 APC film (APC pattern, silver alloy film)

19, 32, 35 ITO film (ITO pattern, transparent conductive film)

23 liquid crystal

25, 33 black stripe (light shielding layer)

34 side slit (light transmitting region)

FIG. 1

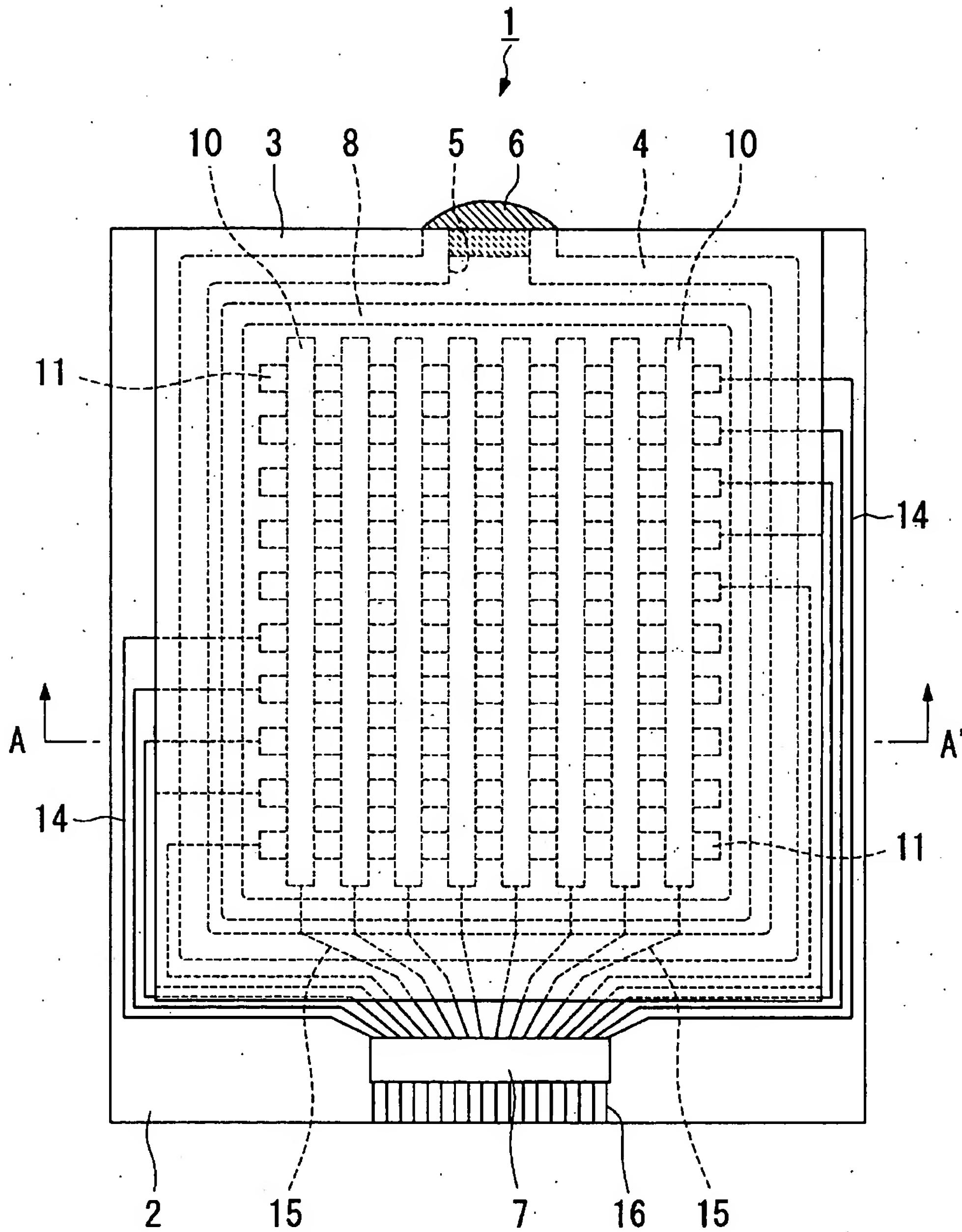


FIG. 2

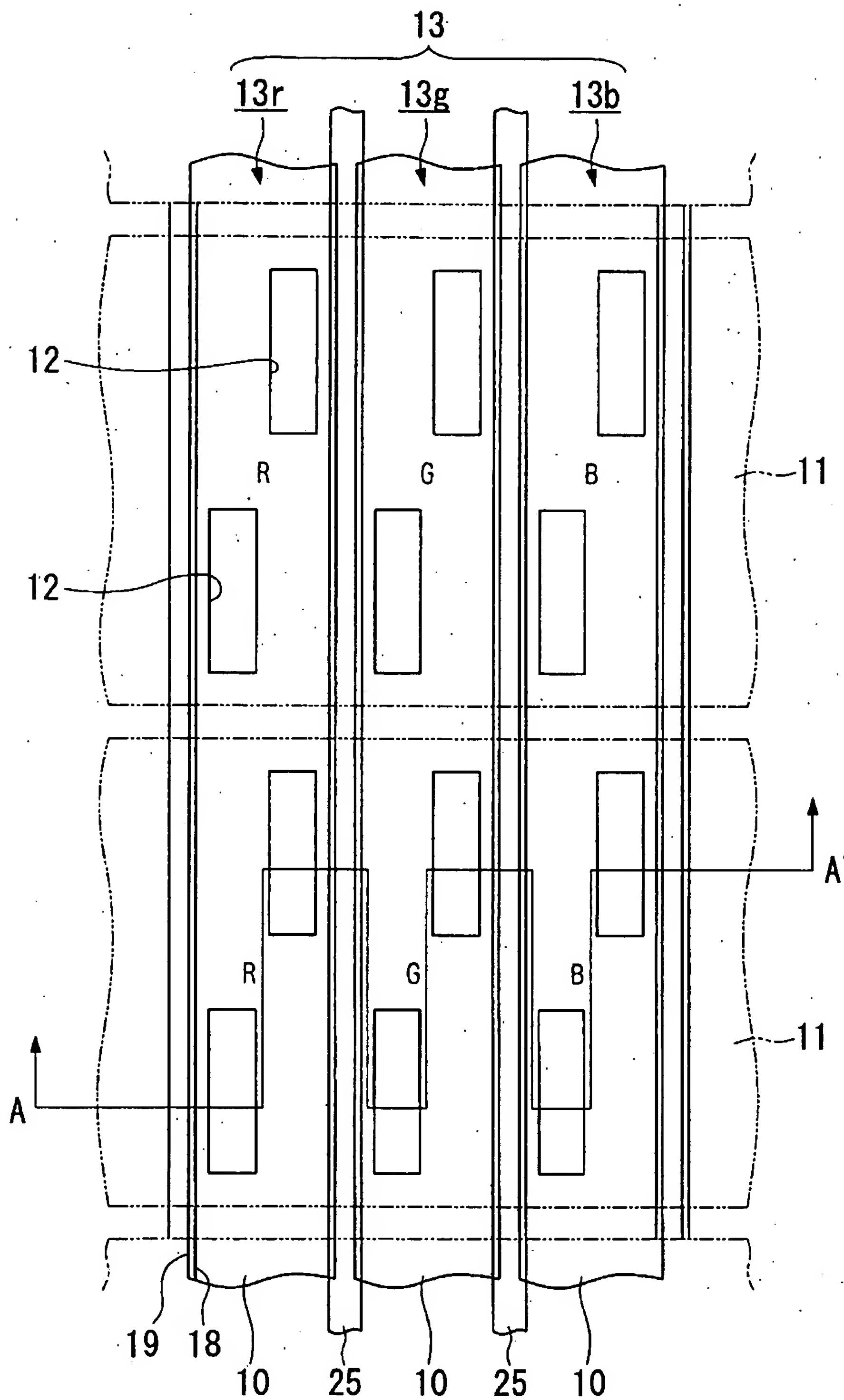
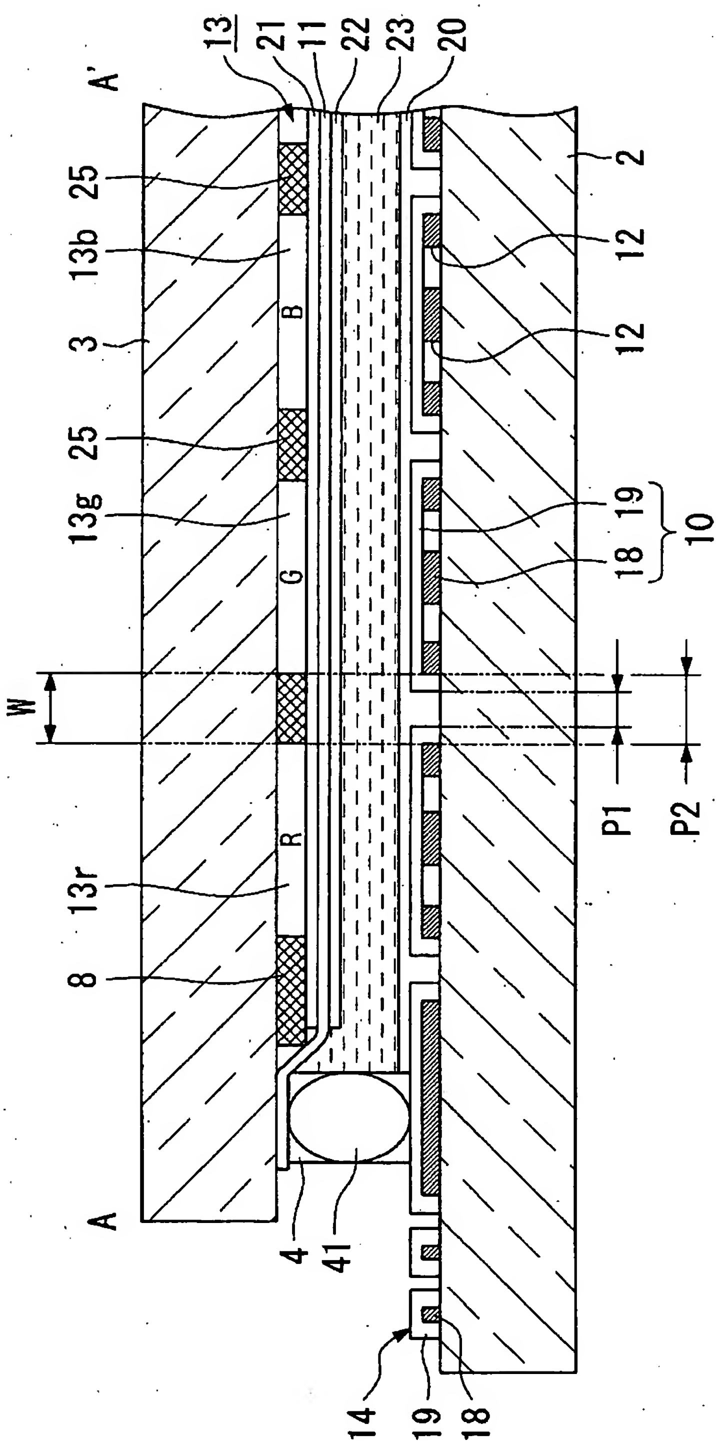


FIG. 3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13g
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P2
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G
R
13r
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A
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FIG. 4

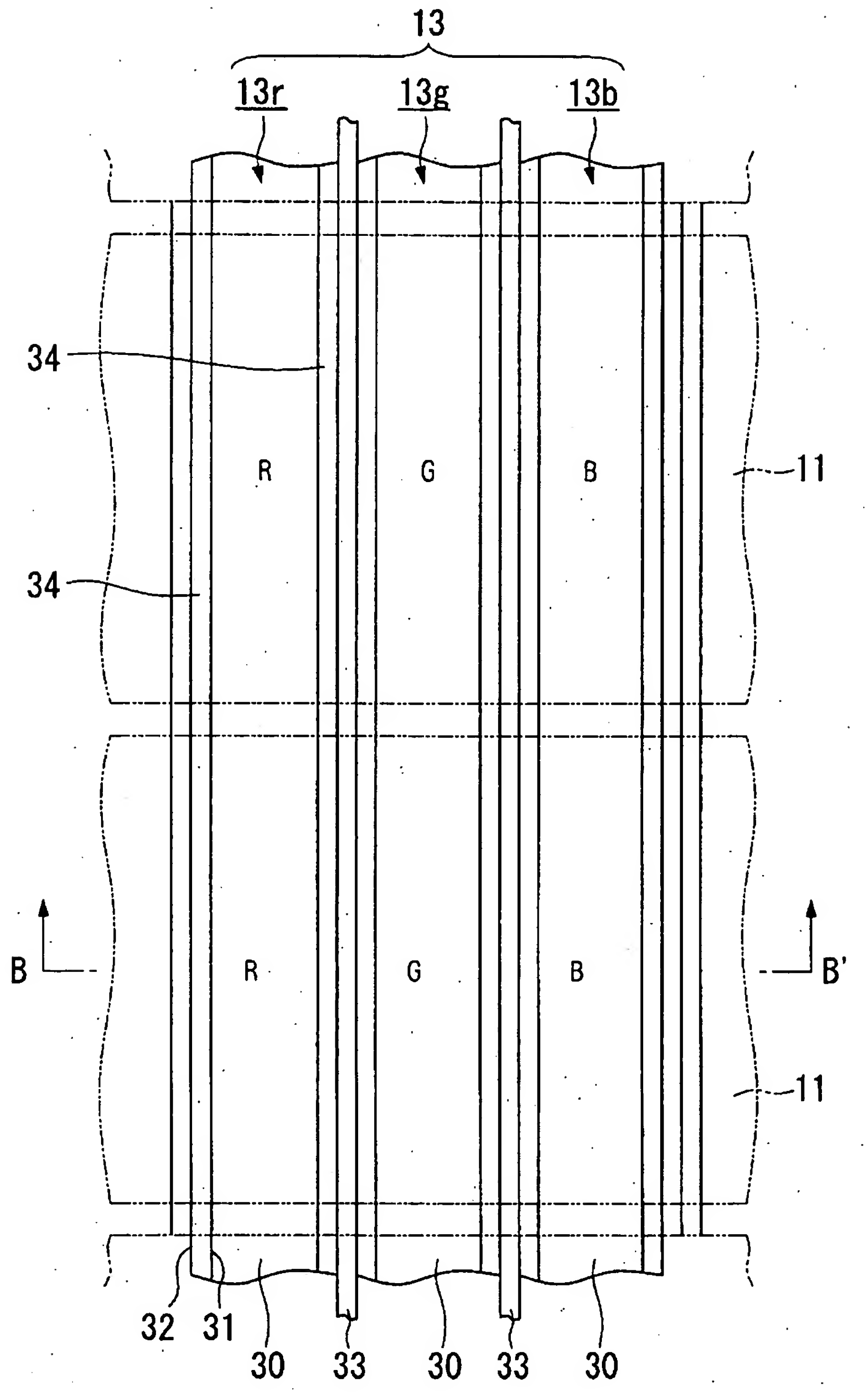
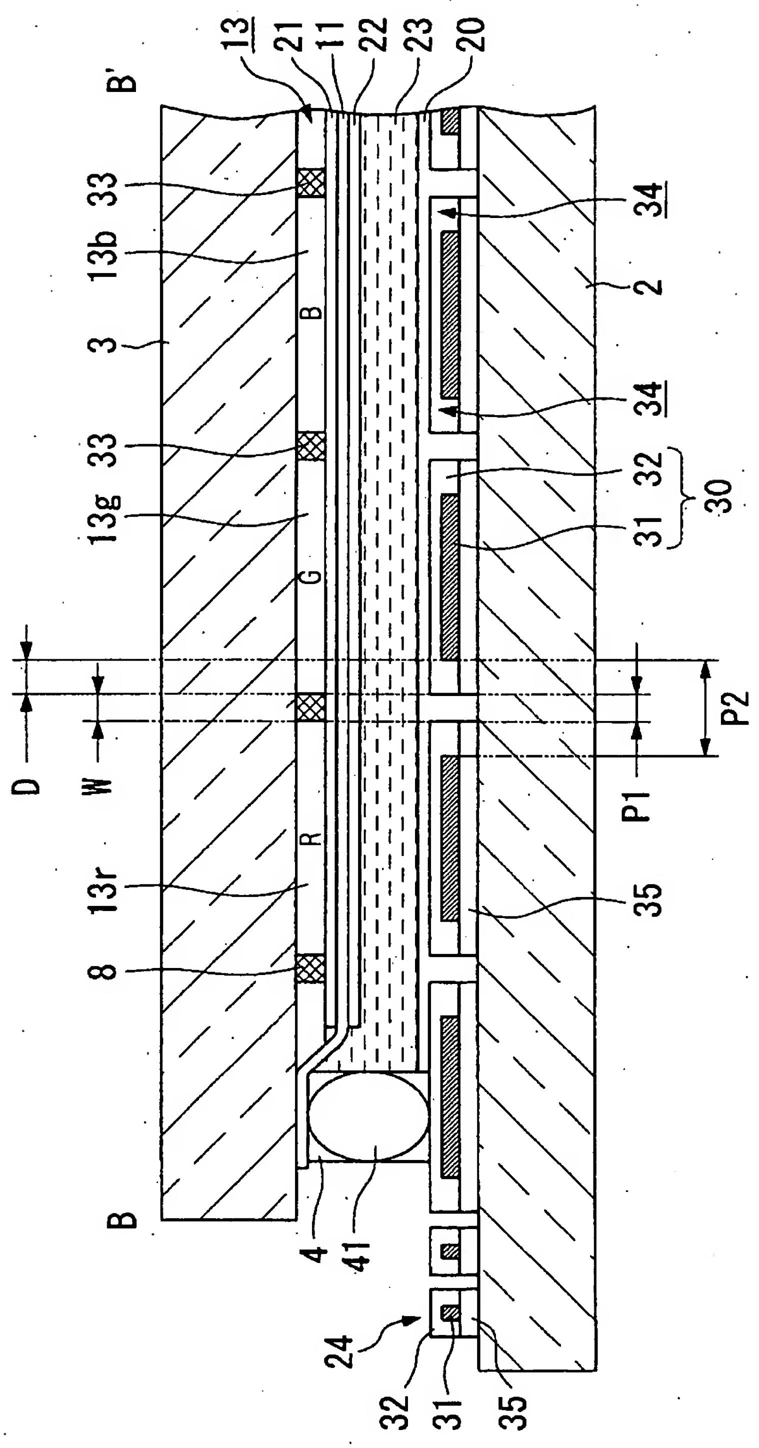


FIG. 5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13g
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D
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P2
P1
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13r
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FIG. 6

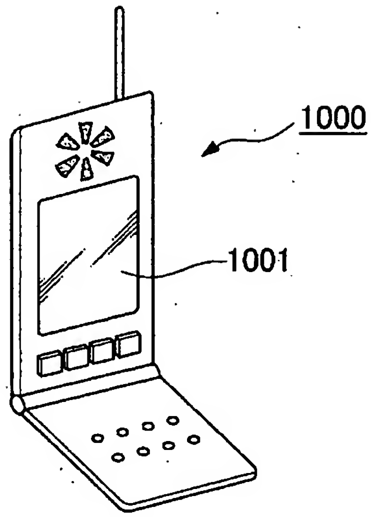


FIG. 7

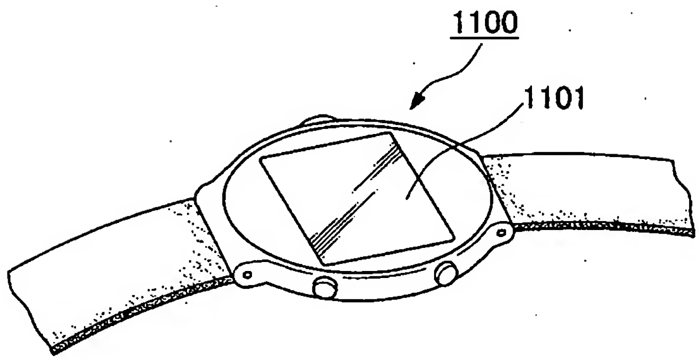


FIG. 8

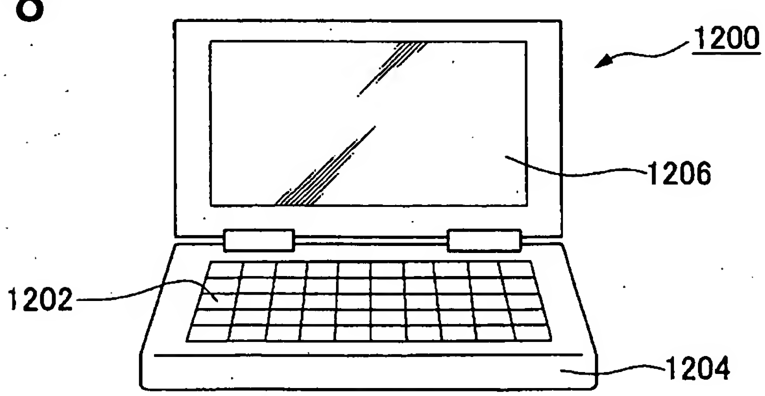


FIG. 9

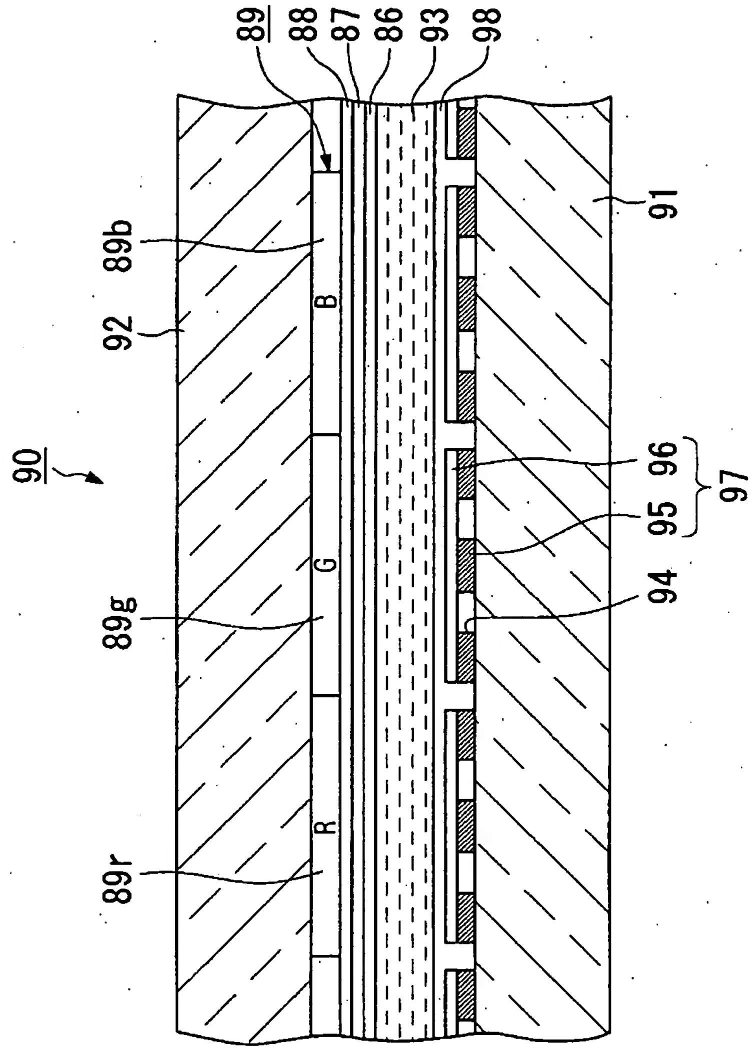


FIG. 10

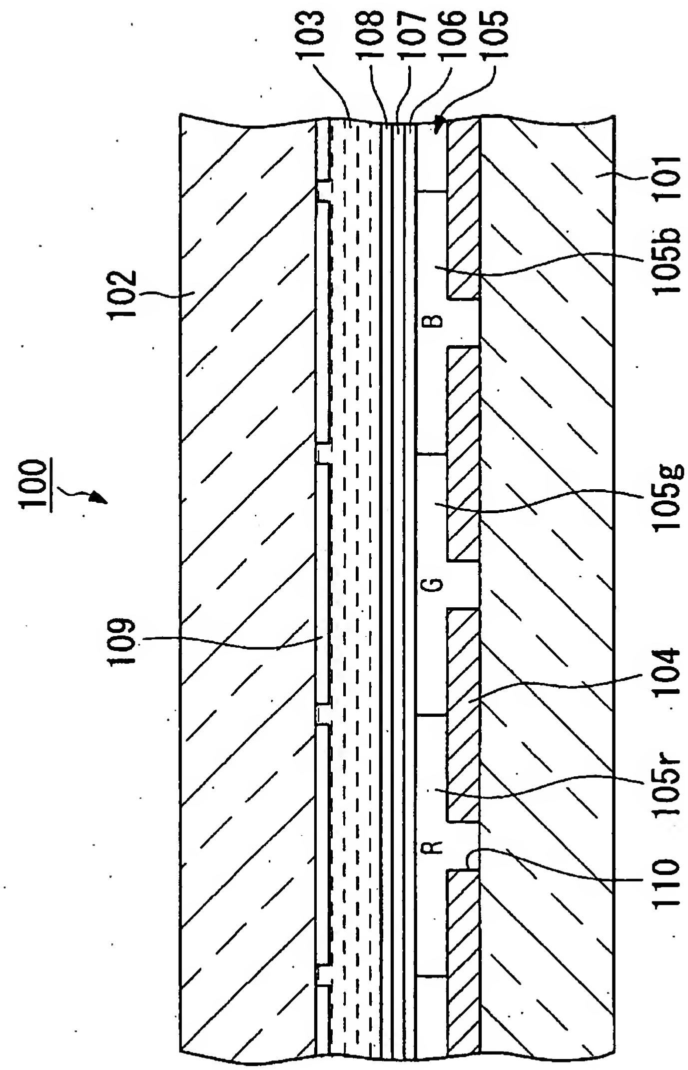
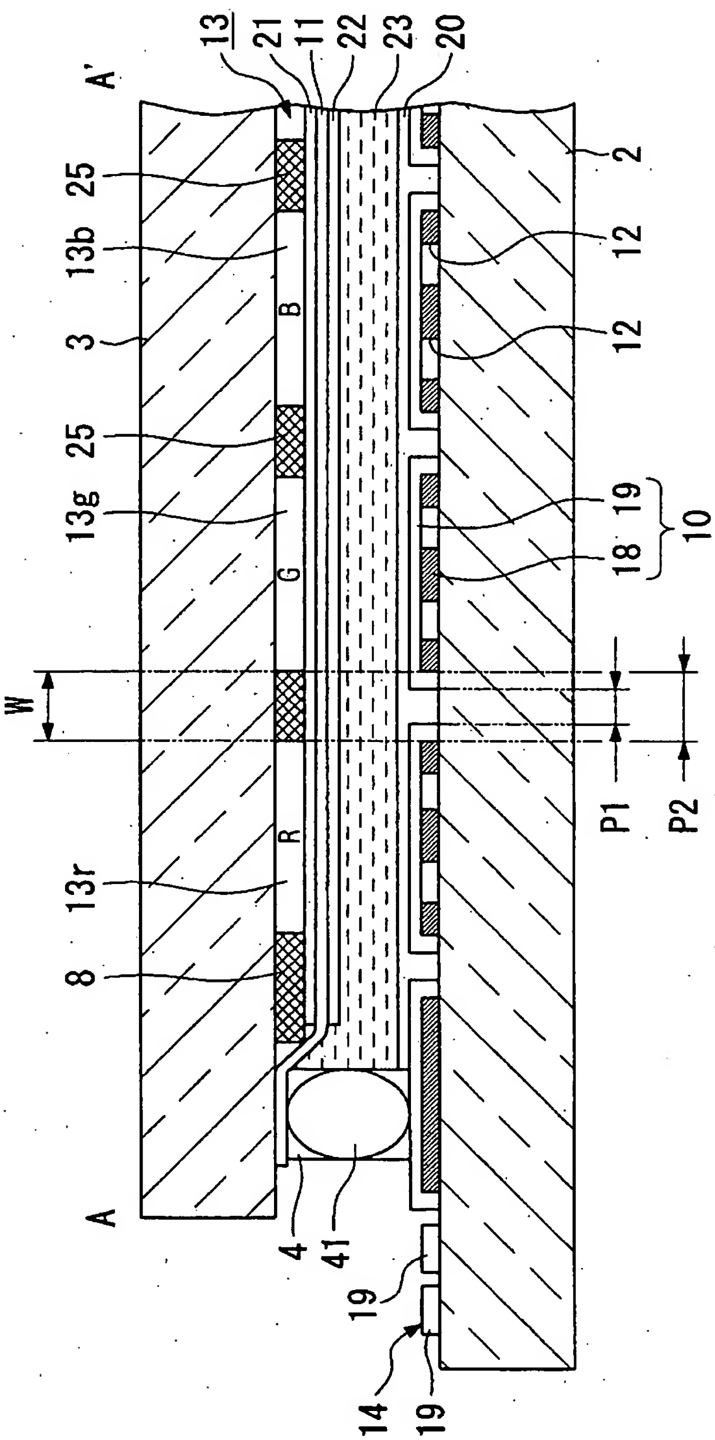


FIG. 11



A'
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P1
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R
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8
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41
19
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19

[Name of Document] ABSTRACT

[Abstract]

[Object] To provide a transflective color liquid crystal display exhibiting brightness in a reflective mode and each color vividness in a transmissive mode.

[Solving Means] A liquid crystal display includes segment electrodes 10 provided on a lower substrate 2 and each having a laminated structure of an APC film 18 and an ITO film 19, a color filter 13 including R, G, B colorant layers, and common electrodes 11 including ITO films, the color filter 13 and the common electrodes 11 being provided on an upper substrate 3. The segment electrodes 10 have light transmitting windows 12 for respective pixels, only an ITO pattern being partially present in the light transmitting windows 12. Also, lead wiring electrically connected to the segment electrodes 10 or the common electrodes 11 and having a laminated structure of the APC film 18 and the ITO film 19 is provided on the lower substrate 2, and the upper surfaces and the sides of the APC films 18 constituting the segment electrodes 10 and the lead wiring are covered with the ITO films 19.

[Selected Figure] Fig. 3